SUPPLEMENT.

The Mining Journal,

RAILWAY AND COMMERCIAL GAZETTE

FORMING A COMPLETE RECORD OF THE PROCEEDINGS OF ALL PUBLIC COMPANIES.

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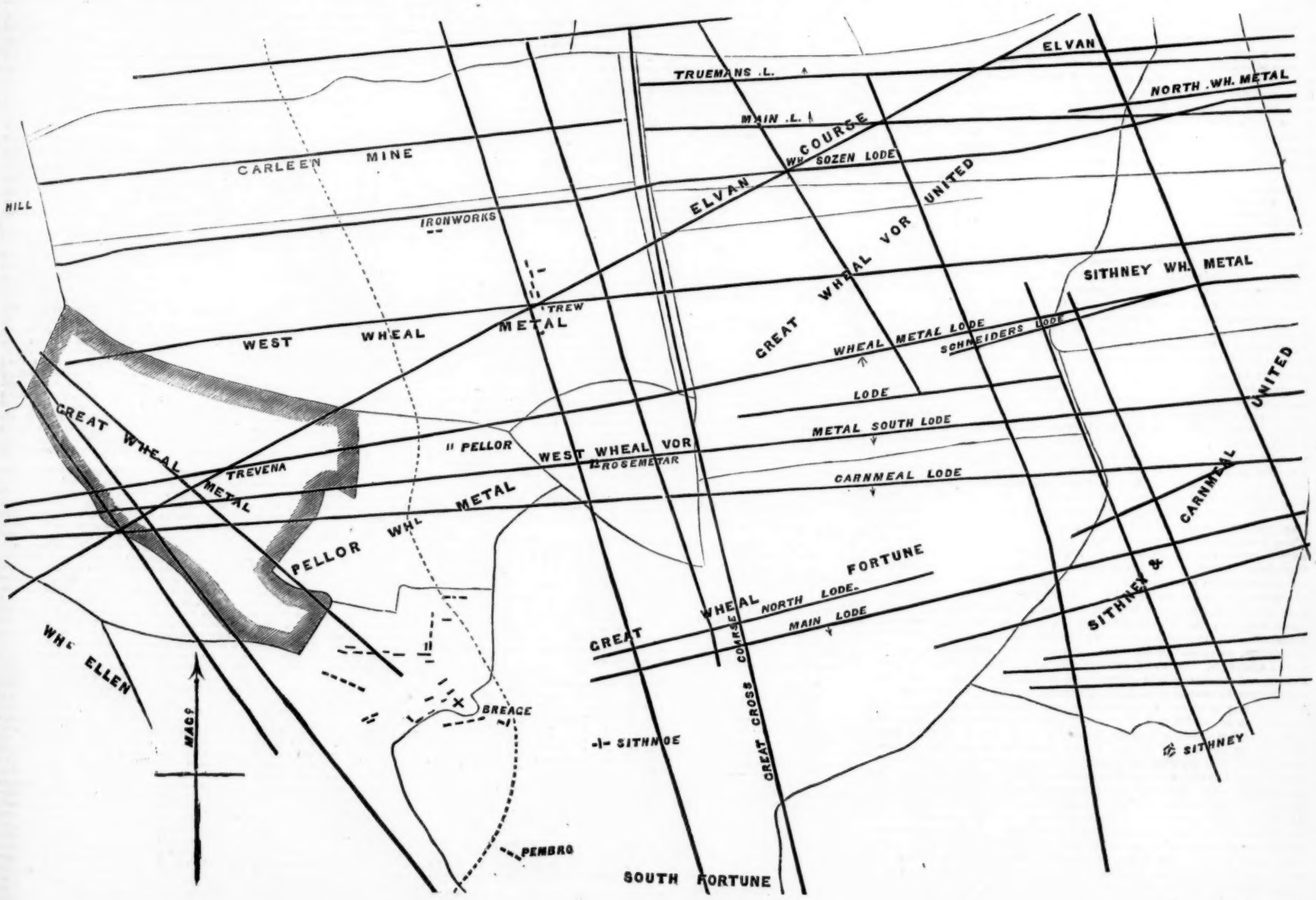
PLAN OF THE GREAT WHEAL VOR MINING DISTRICT.



About half a century ago there dwelt in Goldsithney, a village just on the eastern margin of the famous Mounts Bay, of Cornwall, the Messrs. Gundry, a family of bankers. They were men of affluence, probity, and in possession of all the social virtues to a high degree; in fact, in the strictest sense of the word they were pure and high-minded gentlemen. The firm consisted of three brothers, and whatever they touched turned into gold. They were a type of the Cornish or Celtic family; a short and thick-set race, and, with their Cornish constitution, possessed the faculties peculiar to that people,—an indescribable energy and love for mining. Their instincts in pursuit of metal were so true (an instinct which is inscrutable, but still in various people perfectly marked) that they opened up rich mines, beginning with Old Wheal Neptune, one after another, to the astonishment even of the natives themselves. First Wheal Neptune, then Wheal Speedwell, then Wheal Rodney, all mines as productive of wealth as the lamp of Aladin, for the money came in in showers from these rich copper veins. They then commenced Wheal Vor—that Great Wheal Vor, the present selling price of which is 240,000*l.*! that Wheal Vor that made from 36,000*l.* to 48,000*l.* a year profit to the unfortunate shareholders, for these rich shareholders were unfortunate to a degree, that Wheal Vor which has produced two millions sterling worth of tin. Ere this, no doubt, many of our readers will have concluded that all those fine qualities and riches would have secured the good will and friendship of all their neighbours through an atmosphere of many miles around; if so, they were never more deceived in their lives.

At that period (but it is not to be assumed that such would be the case in the present day) they were persecuted and pursued by envy in every direction. The devil seems to have taken alarm at their goodness, and to have concentrated upon them the conflicting powers of envy, hatred, malice, and all uncharitableness; their coming nobility was nipped in the bud, and their well-deserved popularity scattered to the winds, but still those who remain of the family to this day enjoy the gift of a nobility of nature, and the esteem and respect of all good men, of which man cannot deprive them. It seems that the Messrs. Gundry, in opening the Great Wheal Vor Mine, had felt the influence of coming riches, and relying on the great and discovered value of Wheal Vor and their other rich mines, in an unwary moment had issued more of their paper than there were immediate resources in the till to meet; the vultures, ever upon the wing, and watching the slightest divergence of their quarry, were down upon them, and they were struck a blow, in a monetary sense of the word, from which they could not recover. Great Wheal Vor still went on paying thousands a month profit. It appears the legal chain that drew this great property over from its rightful owners to another set of occupiers was defective in some of its links, and the lawyers had to be called in in order to tinker and weld them. Need we predict the consequences? In our present appreciation of legal science we think the result will be patent to all. Of course, the law swallowed up all the profits; and, more than that, it drove the management to institute a system of reduction of tutwork, which ended in the complete destruction or paralysation of this splendid property, but not until it had reached a depth of 300 fms.—a depth so great that the blacksmiths had to be transported from shops on the surface to shops underground; and the continual ring of the hammer, sharpening the mining implements, went on as merrily at 500 yards perpendicular under the surface as it was wont to do at grass. We may hint a word of caution to our readers. Gentlemen, whenever you are intent on mining, conduct all the affairs of your mines by the rules of law; and, mind, if you have any disputes amongst you, settle them by arbitration rather than by law. The lawyers are a good sort of people, and do not usually lay hold of peoples estates before they are asked; but, once invited, they make very free with any hospitality placed then at their disposal.

In the second campaign of working the Great Wheal Vor Mine, the expenses culminated at a quarter of a million sterling. The finest and largest pumping-machinery ever invented was suggested for the purpose of working the mines, and skilfully applied by Messrs. Hocking and Loam, a firm standing high amongst the great engineers of that county, and famed for the care and certainty of action of such great undertakings. After a time, appalled at the immensity of the pecuniary draughts upon them, some of the shareholders succumbed, others withdrew, but a few, enabled by the favours of fortune and the boldness of genius, stuck to the ship when she was almost pronounced a wreck, and their intrepidity has been rewarded by finding a course of tin on Wheal Metal lode worth 500*l.* per fathom. There are few of our readers who can realise all the mining intelligence that is conveyed by these words, "500*l.* per fathom;" it means that if the course of tin holds for a length of 50 fathoms, the proprietors will be enabled to sell 25,000*l.* worth of tin per month, which, at a profit of one-quarter, which is a fair average in mining, would give them dividends to the extent of 70,000*l.* a year, so that, in placing the capital value of their property at 240,000*l.*, these gentlemen are far from extravagant; it is, in fact, not four years' purchase of the value of the income of the mines. The mining prospectus we publish to-day is for working a continuation of this Great Wheal Metal lode. Need we say anything in advocating the merits of this project? We think not. The reports of several of the most eminent of the Cornish engineers speak for themselves. The geological plan appended, from the careful hands of Mr. Symons, may be relied upon as truthfully setting forth the geologic merits and position of the works; and their establishment, so far as human prescience goes, can only end in prosperity.

PLAIN PAPERS ON GEOLOGY—No. II.

BY THOMAS STRUTHERS.

IGNEOUS ROCKS—THEIR ORIGIN AND COMPOSITION.—In the classification of the rocks of the earth's crust two important natural agents are recognised—on the one hand fire, and on the other water, and thus we have the results designated, respectively, igneous and aqueous rocks, the latter including those formed by organic agency, as well as by the chemical and mechanical action of air and water. Many of the igneous rocks of the present day issue in molten streams from vents in the earth's crust, and overspread considerable areas of its surface previous to their consolidation, while not a few are ejected in the form of mud, sand, and loose ashy materials. Such are the lavas and other substances discharged from the craters of active volcanoes, with which different regions of the earth are studded. These modern igneous products are distinguished as volcanic rocks to indicate their undoubted origin, while the ancient rocks, analogous to them in structure and composition, and consequently of presumed volcanic origin, are denominated trap-rocks, on account of the terraced or stair-like outline, which elevations formed of them not unfrequently present, a feature owing to the abrupt termination of a series of beds piled on each other, which indicate successive outbursts of rock-matter from volcanic vents of the far distant past. The term "trap" is, by some, used to indicate only certain varieties of these ancient volcanic products, but it is generally applied to all of them. The following table will illustrate the composition of the principal varieties:—

Mineral.	Mineral.	Mineral.	Rock.
Felspar	—	—	Felstone.
Felspar	Augite	—	Basalt.
Felspar	Hornblende	—	Greenstone.
Felspar	Hornblende	Quartz	Syenite.

In the first column is felspar, which may be regarded as the basis of the trap-rocks. It is not a simple mineral, being a chemical combination of silica, alumina, and an alkali—commonly potash, but sometimes soda, and occasionally both. Common, or potash-felspar, is called orthoclase, from its straight cleavage, while soda-felspar is distinguished as oligoclase, and, on account of its white colour, albite. In the trap-rocks felspar exists in a granular form, and is known as the rock felstone, which exhibits a variety of buff, reddish, or greenish-grey tints.

In the second line of the table the mineral augite is added, and the rock basalt is the result. The term augite is derived from a Greek word signifying lustre, and this mineral is also known as pyroxene, a word which assigns its origin to fire. It is composed of varying proportions of silica, lime, magnesia, and alumina in chemical union, and is usually of a black colour. The rock greenstone may be regarded as consisting of felspar and hornblende, the latter mineral closely allied to augite in its composition, but commonly supposed to contain less lime and more alumina.

The distinction between these two minerals, however, appears to be based more upon a difference of crystalline form than of mineral composition, and some eminent mineralogists even regard them as the same mineral, presenting a difference of crystalline structure only on account of the different degrees of rapidity with which it had cooled. This view may be regarded as confirmed by the fact that crystals of augite, on cooling slowly, after being artificially fused, assume the crystalline form of hornblende. In some varieties of greenstone hornblende largely predominates, usually in a crystalline form in a matrix of granular felspar, an analysis of the rock differing but slightly from that of hornblende itself. Such a rock may be termed either hornblendic-greenstone or amphibolite-greenstone. We give the following analyses, for the sake of comparison:—

	Hornblendic-greenstone.	Hornblende.
Silica	46·55	47·86
Alumina	8·05	13·24
Protoxide of iron	10·71	9·05
Lime	5·32	14·41
Magnesia	29·45=100·08	15·44=100·00

It must be understood that the composition of hornblende varies to some extent. The analysis given is one of three from "Jukes's Manual of Geology." Basalt varies in colour, being black, bluish, or leaden grey, and is of a more compact and uniform texture than greenstone, in which the light-coloured specks of felspar are usually perceptible to the naked eye. A splintery felspathic variety of basalt gives a ringing metallic sound when struck, and is on that account called clinkstone, and used in the construction of rock harmonicons. When quartz is added to felspar and hornblende we have syenite, a rock which may be regarded as a link between the traps and granites; the trap-rock of that name may, however, be distinguished as *greenstone* syenite. The dull earthy varieties of trap are called claystones, and some geologists call the felstones compact claystones. The still softer varieties, which appear to be volcanic mud slightly indurated, are denominated wacké. Volcanic ash is of varied composition, and sometimes highly indurated. It has, apparently, been ejected from subærial, insular volcanic cones, and scattered in the surrounding waters, where it has been arranged in layers, like a purely aqueous rock, for which it may be readily mistaken. Tufa, or trap-tuff, is another of the trap-rocks, and consists of numerous fragments of various rocks, reunited in an earthy volcanic matrix. Pitchstone, so called from its appearance, is a felspathic variety of trap, and allied to pumice and obsidian, the products of modern volcanoes. These rocks appear to contain a larger proportion of silica than the ordinary felstones, and, consequently, feel rough to the hand—hence the term "trachyte," by which they are distinguished. Most of the trap-rocks occasionally contain macles, or imperfect crystals, of a different colour from the general mass, and are described as porphyritic. Thus we say porphyritic greenstone, porphyritic felstone, &c.; or, reversing the terms, greenstone-porphyry, and felstone-porphyry; and when such rocks contain rounded nodules they are termed amygdaloidal: for example, amygdaloidal greenstone, amygdaloidal claystone. Amygdaloidal pitchstone is usually called spherulite. The nodules appear to have been mostly formed by infiltration, and consist of calcite, glassy felspar, or zeolitic minerals. The larger cavities usually contain more than one mineral, apparently formed in succession. It may be observed that porphyry, *par excellence*, may be regarded as a reddish or greyish rock, more nearly allied to granite than to any of the trap-rocks, but differing from the former in being devoid of mica, more compact, or less crystalline, and having specks or macles disseminated through it. The nodules in amygdaloidal rocks sometimes consist of a dark coloured kernel, enclosed in a coating of light coloured matter. The so-called orbicular granite of Corsica is a good example. It is not a granite, however, but a greenstone, of the variety called diorite, in which the felspar is albite. Some good specimens were procured near Glasgow, during the operations for introducing water from Loch Katrine. The markings have the appearance of birds' eyes, and the term "ocular" is, perhaps, as applicable as orbicular. The slaggy, or vesicular structure of trap-rocks is not unfrequently the result of the decomposition of the amygdaloid nodules, where the rock has been exposed to the action of the air, which gives it what was not inaptly termed by a non-geological observer, a "worm-eaten" appearance.

Another class of rocks to which an igneous origin is attributed differs in many respects from either the modern or ancient volcanic rocks already noticed. Although generally believed, in accordance with the late Dr. Hutton's opinion, to have been originally in a state of igneous fusion, the rocks in question do not appear to have been ejected like the products of volcanoes, but to have cooled and consolidated under the surface, and been either thrust up subsequently by volcanic agency, or exposed by the superincumbent strata having been carried away by the denuding action of ice or water. These are distinguished as Plutonic rocks, and they comprise the different varieties of granite.

The theory of the aqueous origin of granite, however, seems not yet entirely abandoned. If granite be an aqueous rock, the conditions necessary to its production have ceased to exist; for, although extensive researches prove that our seas and lakes are the repositories in which various materials are in process of becoming consolidated into rocks, none of these appear to be of granitic structure. In the case of trap rocks, we have comparatively little difficulty in tracing their origin to fire by analogy, for there are similar rocks in the course of formation in our own day in volcanic regions; but no modern granitic rocks come under our observation, unless we accept the statement of Prof. Haughton and other eminent geologists, that some modern volcanic elevations exhibit rocks of granitic structure at their roots. Many granitic districts also exhibit passages or transitions from granites into trap rocks. Opposite conclusions have been arrived at from a microscopical examination of granite, which reveals the presence of a volatile liquid in minute cavities. This, however, is also the case with the more deeply-seated rocks ejected from Vesuvius during eruption, and Mr. Sorby shows that "the microscopical structure of the constituent minerals of granite is in every respect analogous to that of those formed at great depths, and ejected from modern volcanoes, as though granite had been formed under similar physical conditions, combining at once igneous fusion, aqueous solution, and gaseous sublimation. The proof of the operation of water is quite as strong as of that of heat."

Turning our attention to the composition of the Plutonic, or granitic rocks, we find that they are distinguished by the presence of quartz, or free silica. In constructing a table of varieties, we may, therefore, set down quartz in the first column. There are no rock masses consisting of quartz alone which can be assigned to igneous agency, and even quartz veins are of doubtful origin. The rock called quartzite is of a sedimentary character, and may be regarded as a highly indurated siliceous sandstone.

Mineral.	Mineral.	Mineral.	Rock.
Quartz	Felspar	—	Binary granite.
Quartz	Felspar	Mica	Granite proper.
Quartz	Felspar	Hornblende	Syenite.

Adding to quartz felspar, which, in granite, assumes a more less regular crystalline form, we have a binary, or twofold, granite, and with mica, granite proper. The substitution of hornblende for mica constitutes a granitic syenite. In some specimens of granite both hornblende and mica are present, and the result is a quaternary granite, usually distinguished as a syenitic granite. The red colour of some granites is due to the presence of peroxides of iron in the felspar. Porphyritic granite is formed by the dissemination of distinct crystals of felspar through the mass. These are absurdly styled by some miners "horses' teeth."

It is rather rare to find free silica—that is, distinct or uncombined particles of quartz in greenstone, or other trap-rocks; but when it does exist in fair proportion with the two minerals—hornblende and felspar in a granular form—we may call the rock a greenstone syenite, which is an approach to the granitic rocks, but distinguished from them by the absence of the more crystalline structure by which the felspar of the granites is usually characterised.

BOLIVIA AND ITS RESOURCES.

[FROM A CORRESPONDENT]

Much attention being at present directed by English capitalists to the mineral resources of Bolivia, the few remarks subjoined will probably be acceptable to your readers, in continuation of the excellent letters of Mr. H. Macaulay Punnett on the Tin Deposits of Bolivia, published in June and July last. The population of Bolivia is about 2,500,000, and its extent about 1100 miles by 750 miles. The Government consist of a septennially elected President, a senate, and a house of assembly, and the revenue of the country, which is lightly taxed, is generally in excess of the expenditure; the total revenue is about 600,000*l.* The annual exportation of Bolivia is—chinchona, 200 000*l.* value; copper, 800,000*l.*; tin, 200,000*l.*; gold, 200.000*l.*; silver, 600 000*l.*: total, 2,000,000*l.*, whilst the annual importation is about 1,500 000*l.* Bolivia is one of the most favoured spots of the globe, containing every thing that can be produced under the torrid and temperate zones in the three kingdoms—mineral, animal, and vegetable. It is to the first of these that the readers of the Journal will attach particular interest, although they will readily appreciate the advantages accruing from the abundance of useful animals and valuable vegetable productions existing there.

Bolivia is rich in its ores; its mountains contain mines of gold, silver, cinnabar (or quicksilver), talc, lead, tin, copper, iron, coal, and fossil salts, emeralds and other precious stones, among them the celebrated berenguela, and every class of jasper. The department of Sucre was called La P ata, in consequence of the number of silver mines surrounding it. In the province of Zinti there are some very productive lead mines, now at work, in the settlement of Potacaca, and saltpetre pits are found running for leagues through this department, which are at present used only for home consumption. In that part of this province bounded by Tarrija, to the west-south-west, different colours are observable in the earths and clays, so that if industrious and skilful potters were located there they would have better materials for the production of porcelain than exist in England. In the province of Tonmia gold, silver, and various other metals are found. Those discovered up to the present time are silver ore mixed with lead (piomo ronco), red gold ore (rosiclere), silver ore, consisting of brown oxide of iron and native silver (paco), sulphuretted indigo-coloured ore, &c. The province of Oruro abounds in gold and silver mines, which were formerly very famous, during Spanish rule; most of them have been abandoned since the revolution, but the mines of Popo are still worked, and yield much silver. The province of Carancas commences 70 leagues west of Chuquisaca, and extends about 50 leagues on the west bank of Lake Paria. It produces horned cattle, vicunas, and animals of all kinds. There are also many silver mines, two of which are very productive, and one of copper, equally so, is at present worked to great advantage. A singular ore is found in the mines of an estate called Turco, which consists of beautiful fibres of silver penetrating the mass of stone in which they are contained. In the sandy desert of the province of Carancas, that extends towards the Pacific, are discovered lumps of native silver, which are called "papas," or potatoes, because they are dug out of the earth like that root; these lumps have the appearance of melted silver, and many of them have been found weighing 150 marks, and more than a foot in length.

The city of Potosi, the capital of the province of the same name, is built in a narrow glen, on the river of the same name, and on the south side of the mountain that contains the mines. A royal mint was established in this place in 1562, and so rapidly did its population increase that in 1611 the city contained 160,000 inhabitants; but from various causes the population has continually decreased, and at present it consists only of about 42,000 souls. Its inhabitants are chiefly employed in the working of the mines. The celebrated mines of Potosi are in the mountain at the base of which the city is built; this mountain is three miles in circumference, and is of a sharp conical figure, rising 4360 feet above the level of the plain. At the latter end of the 16th century, during the Spanish government, 15,000 Indians were forced to work in the mines, but at present there are not more than 2800 miners, who are well paid; 15,000 llamas and 15 000 asses are constantly employed in carrying the ore to the amalgamation works in the city. In 1790, 299,246 piastres of gold, and 3,293,173 of silver, or 886,626*l.* sterling, were coined in the mint of Potosi. From the first discovery of those mines until 1803 they have supplied 1,095,500,000 piastres, or 237,358.334*l.* sterling, of silver, which large sum has paid the royal duties. As this only includes silver, the gold and other metals that were smuggled would consequently have, if carried to account, greatly increased the total furnished to the works. Potosi is distant from Buenos Ayres 1873 miles. The richest shafts or workings of the mines are on the side of the mountain, and are called La Descubridera del Estano, La Sica, and La Mendieta, their direction always running south.

During the revolutionary war, when Bolivia, in common with other South American states, fought against the government of Spain, the mining industry of Bolivia received a check, from which it has not recovered. The disturbed state of the country for some time after its independence was declared diverted the attention of the mining population from its usual pursuits, to which they and their children are now returning, under the present settled Government; and with the continuance of peace, and the proposed application of the funds to be raised in Europe to the making of roads and bridges, the mineral production of Bolivia, especially that of the precious metals, will annually increase, and hundreds of rich mines, the working of which was stopped during the war, will be resumed. The mines of Potosi, which have produced 360,000,000 sterling, are inexhaustible. The following list will show the mines which are at work, and which are suspended, most or them from the effects of the war:—

	At work.	Suspended.
Potosi	26 mines	1800 mines
Porco	33 „	1519 „
Chayanta	18 „	120 „
Chicas	22 „	650 „
Lipes	7 „	760 „
Oruro	11 „	1215 „
Poopo	15 „	340 „
Carangas	14 „	285 „
Sicasica	9 „	320 „
Sorata	7 „	50 „

It will, therefore, be seen that the exportation of the precious metals has decreased in Bolivia, not because the mines are exhausted, but because the working population had been taken away, and the works suspended, and that the gradual increase of production, within the last two or three years has arisen from a settled Government, and the resumption of the working of the mines; and if the views of the Bolivian Government be carried out by the assistance of the present loan, Bolivia will be to Europe what Australia and California have been during the last fifteen years. The exportation of gold has not been very great, because the people have retained it as a circulating medium; but if the proposed extension of the mint and increased facilities should be carried out, the exportation will largely increase.

The chief commerce of the province of Lipes consists in the produce of its mines, of which two are of gold, one of silver, and one of copper, which are now worked, and are said to be very productive. The silver mines of Chrystoval de Acochala were formerly the most valuable in Peru, but at present they are not worked. The mountain of Porco, in the province of the same name, is celebrated as having been the place whence the Incas of old of Peru drew the greatest portion of their silver, and was the first mine worked by the Spaniards after the conquest. This district produces great quantities of that metal, particularly at the settlement of Tomahave, and from the mines of the Porco mountain, which are 23 leagues from Sucre. The River Bermejo, with the Pilcomayo, which are as mighty as any of the most famous rivers in Europe, afford the means of cheap and easy transport by water for all the productions and articles of commerce, either coming from or going to Bolivia. Much gold is found in the River Tipuani, when it is swollen by the melting of the snow, which forces large masses of rock from the mountain of Illimani. In 1730 an Indian discovered in this river a lump of pure gold, of such size that it was bought for $12,000, and sent to the King of Spain. In the province of Pacages there were formerly worked several mines of silver, emeralds, sapphires, and jasper, and a mine of talc supplies not only all Peru but the surrounding republics with plates of that metal to serve instead of window glass for the churches and houses. The province of Chulumani, or Yungas, also possesses many gold mines, and several silver mines, and there are four gold mines in the province of Omasuyas. The province of Larecaja contains many gold mines, the metal found in which is of a superior fineness; and four of its mines are at present in work. The mountain of Sunchuli, in this province, is celebrated as having been the site of a gold mine discovered in 1709, which was worked with immense profit until 1756, when it was inundated by a spring that suddenly burst upon it; and the Indians, not being so versed in machinery as our miners of the present day, found every attempt to get the water under prove to be wholly fruitless.

La Paz produces cocoa and coffee, and the vine and the sugar cane, rice and cotton, are equally suited to its soil and climate. The best description of Peruvian bark belongs exclusively to this part of the republic, and is one of the most abundant productions of this province. Wild cotton, indigo, balsam of copaiba, the raiz of China, caoutchouc, or india-rubber, are all produced here in profusion. Nearly all the streams which descend from the eastern Cordilliera, and from the River Beni, flow over sands with which are mingled particles of gold, and almost all its ridges contain veins of the precious metals. There are also silver mines in Caquisiri, Caquingora, Machaca, Berenguela, Teaguanaco, and Acacachi. There are some emerald mines in Caquivari, native copper in Curaguara, and quicksilver in Guarina. Besides this mineral wealth, its fertile plains and slopes are covered with domestic flocks and abundance of game. The opening of the navigation of the Beni by steam will bring this rich district into direct communication with Europe.

The province of Cochabamba contains amongst its mineral productions native allum, blue vitriol, common salt, rock salt, pure nitre, mineral alkali (loso nativa), native verdigris, and orpiment of Peru. In the mountains of Oropesa are found quicksilver, or mercurial, mines. Acosta observes that the quicksilver at Oropesa is made from the cinnabar, which is a mineral stone, red, heavy, and brilliant; it is considered a marcasita of quicksilver, or rather quicksilver petrified and fixed by means of sulphur and subterranean heat, for it can be chemically reduced without much trouble or loss to quicksilver, so that 1 lb. of good cinnabar will yield 14 ozs. of quicksilver or mercury. The Indians of Oropesa wrought these mines a considerable time before the invasion of their country by the Spaniards, not understanding the nature and value of the mineral; for, as the cinnabar yields a vermilion, they only sought after the stone which they called limpi; this they used, like the ancient Romans, or modern Ethiopians, to paint their faces on their festivals and days of rejoicing. Nor were these quicksilver mines discovered by the Spaniards themselves until 1567, when Henriques Garcias, a native of Portugal, happened to meet with a piece of ore which the Indians called limpi, which he imagined must be the same as the European vermilion, and extracted out of the same ore as quicksilver. In the neighbourhood of this mine precious stones, such as emeralds, turquoise, &c., are found.

It will thus be readily understood that Bolivia has rich and inexhaustible elements of wealth, boundless and unparalled diversity of clime and territory, and the greatest and noblest rivers in the world; for instance, the Amazon, the Madera, the Beni, the Tipuani, the Rio Grande, and the great Pilcomayo, with their many affluent tributaries, one of which at 1800 mites from the South Atlantic is a mile in breadth, and has sufficient depth of water for ships of considerable burden. The rivers Tipuani, Beni, Paruo, Madera, and the Amazon on the north-eastern side, which flow into the North Atlantic—the great River Pilcomayo, which pours its mighty waters into the Paraguay, and thence into the Rio Plato, flowing into the South Atlantic, has not a single obstacle to its free navigation of vessels of considerable draft of water until it reaches almost to the centre of the Republic of Bolivia. The Pilcomayo would be regarded as a river of the very first magnitude were it not in the presence of the Amazon.

The climate of Bolivia is healthy, many extensive portions of it particularly so; indeed, Sir Woodbine Parish, F.R.S., in his official report on the River Beni, published in the Journal of the Royal Geographical Society, remarks, the climate is so mild and salubrious that it may be said truly there is none like it on this Continent, as a proof of which, in the settlement of Guanay, in a population of 240 souls, there has not been a single death of man, woman, or child in two years and five months. The soil is rich, while the uninterrupted softness of the climate, and some peculiarities, the cause of which are not as yet fully ascertained, enable it to produce spontaneously a great and valuable vegetable variety. The Rivers of Bolivia have their early progress amid the gold mines of Tipuani, and flow through that rich mineral region from which such immense wealth has been already extracted, and which would seem still to be inexhaustible.

Its inhabitants are industrious and enterprising, and although living in the richest district in the world, they have not the advantage of accumulated capital. The War of Independence was the first blow at their national prosperity, and the civil commotions which followed have impoverished the country. Bolivia is now, and has been for some time, free from civil strifes. All parties and all sections are agreed on upholding its present constitutional system, and supporting its present Government. The Legislative Assembly have passed a law, hypothecating the revenues of the State for the interest and annual repayment of a small loan in Europe, and devoting its proceeds to the development of internal communications, in the construction of roads and bridges, the establishment of a bank, and for the succour and support of the mining interest. If these objects be accomplished, in the words of Mr. M. M'Culloch, "The products of Bolivia will meet with a ready and advantageous outlet, and her all but boundless capabilities of production, which at present can hardly be said to be in any degree availed of, will receive a stimulus, of the influence of which we can form no adequate idea."

ATMOSPHERIC GAS.

The advantage of atmospheric gas, as compared with every other means of illumination, in every position where coal gas from an organised company is not available, is so generally admitted that there can be no question that there is an ample field open to inventors in this direction. Among the most recent and more successful contrivances is one by Mr. Drake, of Boston, U.S., designated the Automatic Gas Machine, and which has been severely tested by Dr. Hayes, the State assayer, and reported upon in the most favourable manner. He describes Mr. Drake's machine as an apparatus combining successive improvements, by which air is drawn in and passed over absorbing surfaces, greatly extended, and successively moistened with fluid hydro-carbons, called gasoleine. Power is obtained by the regulated descent of a weight, which causes a steady flow of gas, when a tap connected with the machine is opened. There is a regulating reservoir, and an arrangement for admitting air to mix with any rich mixture formed in the way of dilution when required. It is simple in construction, and easily managed by even ignorant persons. The act of opening the tap connected with the burner gives rise to motion and the manufacture of the compound gas. The supply continues as long as a few ounces of fluid remain in the reservoir. Generally, the machine requires winding once a day, when all the burners have been used, and the reservoir ordinarily needs a new supply of gasoleine once each week. Dr. Haye's experiments extended over four weeks, so that every reliance may be placed upon the accuracy of his record.

The gasoleine is a mixture of volatile hydro-carbons, not belonging to the benzole series, and not subject to crystallisation by great reduction of temperature. In the chemical experiments upon the fluid he observed a close resemblance existing between the different fluids composing it, and the fluid forms of condensed gases, where pressure and low temperature induce a new mechanical state, while the resumption of the gaseous form is preceded by a vaporisation. So important is this property of readily passing into vapour at a low temperature, and the kindred one of diffusing at a point far below the lowest boiling point of the compound fluid, that the success of general application to forming the mixed gas is dependent on it. Even the skill and invention of Mr. Drake, connected with the use of fluids of the benzole series, for more than 10 years enabled him successfully to apply them in hot climates only. It has been this necessity for maintaining a high temperature that has caused all previous attempts to introduce atmospheric gas abortive, and if, as Dr. Hayes states, this new fluid can be produced in large quantities from Cannel coal, and obtained as a secondary product in refining petroleum oil, the discovery of an apparatus for utilising it in the production of atmospheric gas will be of vast importance. It appears that at 60° Fahr. the fluid has a specific gravity of 0·6587. In a distilling apparatus little ebullition takes place at 150° Fahr.; at 212° Fahr. more vapour is formed, but the fluid requires 240° Fahr. for rapid distillation. With this high boiling point, which is inconstant, it entirely diffuses rapidly in air, or coal gas, at 60° Fahr. In the use of suitable vessels it may be handled and transported, with no more attendant danger than belongs to alcohol of the greater strength.

The experiments for testing the permanency of the gas were most satisfactory, a reduction of temperature to far below that which in practice would ever take place, showing that a great degree of permanency may be expected. Where water remains fluid it can be depended on for affording light, and when reduced below this point it still burns with flame. Repetitions of this experiment were relied on for knowledge of the constitution of the gas passing. Thus, gas formed at 59° Fahr. had, in consecutive trials for several days, a mean illuminating power of 18 5-10 standard sperm candles, when the usual reductions from less than 4 ft. consumed and 128 grs. of sperm burn d were made. This gas cooled to 10° Fahr., 100 c. f., in passing deposited 2 34-100 lbs. of gasoleine, which had a sp. gr. 0·6524 at 60° Fahr., the normal density was 0 6587—the slight difference showing the almost equable diffusion at such low temperatures. At higher temperatures the gas produced has the character of pure Cannel gas, and as a consumption of 3 6-10 c. f. of gas, formed at 60° Fahr., gives a flame sufficient for ordinary gas, a corresponding reduction of volume for the richer gas must be made, with, perhaps, less economy at the burner. To meet the contingency of a temperature higher than the mean occurring, and in climates nearer the equator, the device for mixing air with rich gas, in order to dilute it, forms a prominent economical feature of the machine. The volume of the gas being increased by the admission of air, the intensity of the light at the burner is diminished to the economical point, a milder diffusible light being obtained, any excess of vaporisation is thus prevented. In ordinary use the machines are placed where the temperature, through the year, is nearly the mean temperature of the locality.

With respect to the economy of atmospheric gas, the doctor remarks that it may be considered as offering a convenient mode of obtaining perfect combustion of heavy hydro-carbon vapours, with the advantages connected with the use of gas for the purpose of illumination. The current of air carries the vapour to the opening of the burner, where it is burnt, and the supply of material must equal the demand for light. The economy of the light was the chief object of the investigation undertaken. The utmost care was given to this point, and the multiplied observations, made on the value of the light during 20 days, included the circumstances likely to occur in the daily use of the apparatus in dwellings, and the influence of varied rates of consumption. When the gas was formed at 60° Fahr.—all the apparatus and fluids being at that temperature—100 c. f. of the gas contained 7-10ths of one gallon of gasoleine. The cost of the material, affording 100 c. f. of 18 standard candle gas, was, therefore, 7-10ths of the price of one gallon of gasoleine. At the time the experiment was made the price of gasoleine was 25 cents per gallon. Now, a higher price is charged for it, and a corresponding increase in the cost of the gas necessarily follows. Atmospheric gas can never be produced at so low cost as coal gas, in favourable locations, and, as an illuminating agent, it can never compete with it in price. But it has special applications, in which a little enhanced cost still leaves it very much more economical in use than other materials are. It has advantages, too, over coal gas, in its superior purity, arising from the absence of all sulphuretted and ammoniacal compounds. The products of its combustion are simply carbonic acid and vapour of water, without any acid salts being formed at the moment or afterwards. In its special application to lighting mansions and dwellings, where good illuminating gas is not supplied, and as a substitute for other materials used for lighting, atmospheric gas, as formed in the apparatus of Mr. Drake, can, in the opinion of Dr. Hayes, be used economically, whilst the neatness and evenness of motion in the machine, combined with the mode of obtaining an extended surface for saturating the air, render the apparatus as near as may be complete.

IMPROVED CAST-IRON.—Cast-iron, composed of old and new metal, in certain proportions, calculated to give it a great power of resistance, acquires a new degree of strength by an addition of 2 per cent. of wolfram, or tungsten. In one of these combinations the increase of the power of resistance to fracture per square centimetre was 44 kilogrammes with French wolfram. In another, formed of one-third of old English cast-iron and two-thirds of old ordnance, the increase, with German wolfram, was 67 kilogrammes per square centimetre. M. Leguen has recently shown that, subjected to a second fusion, cast-iron containing wolfram is still superior to other cast-iron similarly treated. After this operation, the difference of resistance in favour of the former was 26 kilogrammes per square centimetre; and German wolfram is superior to French, even after a second fusion. A third fusion of the same cast-iron having been directly effected in a Wilkinson's furnace, instead of being done in a crucible, as in the preceding cases, the tenacity of wolframed cast-iron was again greater than that of the common sort treated in the same manner. Hence it may be concluded that the action of wolfram subsists even when the fusion is effected directly in a furnace, and remains after several successive fusions. The wolframed cast-iron mentioned above, containing fragments of old ordnance, seems to become stronger at every successive fusion. Another proof of the superiority of wolframed cast-iron over the common sort is that bars made out of the former do not bend so much as the others under the action of equal weights, whence it may be inferred that the wolframed sort is more elastic, and more capable of resistance. In all cases, therefore, in which it is required to have cast-iron offering great resistance to fracture, the addition of a small quantity of wolfram offers an easy means of obtaining it. The wolfram must be pulverised, but need not be reduced. French wolfram must, moreover, be roasted, in order to drive off the sulphur and arsenic it contains; but German, being purer, need only be reduced to powder.—*Galignani.*

LONDON GENERAL OMNIBUS COMPANY.—The traffic receipts for the week ending May 8 was 11,929*l.* 12s. 3d.

NORTH OF ENGLAND INSTITUTE OF MINING ENGINEERS.

A general meeting of members was held on May 5, in the rooms of the Institute, Neville Hall, Newcastle,—Mr. N. WOOD (President) in the chair. After the transaction of the regular business, a paper, by Thos. Sopwith, on the "Lead Mining District," was read *pro forma*. A short discussion on the "True Geological Position of the Anthracite Coal" took place. The further discussion of this question, and also the discussion on Mr. M. Dunn's paper on the "Probability of the Extension of the Coal Measures under the Red Sandstone of Carlisle," was postponed.

A paper was read by Mr. R. HOWSE, entitled "Notes on the Glaciation of the Counties of Durham and Northumberland." The writer states that about the year 1854-5 extensive borings of the Trow Rocks, near South Shields, previous to quarrying the magnesian limestone of that locality for the new pier works, afforded him an opportunity of examining the character and appearance of the rock-surface under the clay, which at this place covered the royalty to the depth of 5 or 6 feet. For a long time his searches for indications of the true rock-surface were unsuccessful, owing to the denudation of the clay-covering in that portion of the quarry first worked, and the consequent defacement and obliteration of the original surface. But as the works proceeded, and the thickness of the clay-covering increased, he was soon gratified with a proof of the former glaciation of nearly the whole of the rock-surface, and the existence upon it, in many places, of a rough angular gravel, and also of large rounded blocks of polished striated and scored mountain limestone, millstone grit, sandstone, and basalt; the latter all derived from the higher lands of the country. On observing the direction of the striæ, and the inclination or slope of this glaciated surface within short distances, it was then, for the first time, suggested to him that these appearances could not be explained by the opinion generally entertained by English geologists of the stranding of icebergs, and the abrasion caused by large masses of floating ice charged with boulders slowly moving over and grazing the rock-surface in the direction of north-west and south-east; for here, within a hundred yards, were glaciated rocks with the striæ, indicating the movement of the glaciating agent to the north, to the north-east, and the east. His conviction was strengthened by the fact that the materials accumulated in the extensive deposits of boulder-clay at the mouth of the Tyne could be traced to the higher parts of that river, and that all the extensive accumulations of this material further to the south contained specimens of magnesian limestone, polished and glaciated, derived from the magnesian limestone plateau, such limestone never occurring in the boulder-clay at the mouth of the Tyne or on the Northumberland coast. It, therefore, appeared almost certain, from these facts, that the moving ice, bearing these peculiar boulders, must have travelled from the west, from the higher ground towards the coast; and that the hypothesis of continental or land ice, involving, as it did, an immense change of climatal conditions to those at present existing, seemed more in accordance with the facts registered in these rocks, and absolutely necessary to explain the appearances of the glaciated surface and the formation and deposition of the boulder-clay than the vague theory of the stranding of icebergs, drifting southwards from some unknown northern locality, and bearing rocky materials not belonging to the country from whence they came. The writer proceeded to illustrate and confirm this theory by describing the superficial deposits resting on the rock-surface of the two localities, and by quotations from the Tyneside Transactions, relative to geological evidences of glaciation at Belsay and other parts of Northumberland.

The PRESIDENT said they were much obliged to Mr. Howse for the trouble he had taken. The paper would be printed in the Transactions, together with any diagrams necessary for its illustration. He also suggested the desirableness of getting an account of the borings through the clay at the different pits in the Northern coal field. If they had an account of the thickness of clay throughout the district, it would be very valuable.

INSTITUTION OF MECHANICAL ENGINEERS.

The general meeting of members was held on May 5, at the house of the Institution, Newhall-street, Birmingham,—Mr. JOHN RAMSBOTTOM (Vice-President) in the chair. The SECRETARY (Mr. W. Marshall) read the minutes of the last meeting, and several new members were elected.

The first paper was a "Description of Harrison's Cast-Iron Steam Boiler," by Mr. ZERAH COLBURN, of London, communicated through Mr. Charles F. Beyer. This boiler, the invention of Mr. Joseph Harrison, of Philadelphia, is constructed of a large number of hollow cast-iron spheres of small diameter, in order to provide great strength against bursting, and to allow of safely working at considerably higher pressures of steam, and to obtain a larger extent of heating surface in proportion to the weight and external dimensions of the boiler. The spheres are connected by hollow necks, and are cast in sets of four together; a series of these castings are secured together all in one plane, by long bolts running through the interior of the spheres, the joints being turned and faced by machinery all to exactly the same gauge, so as to be completely water-tight and steam-tight when the bolts are screwed up. This series of spheres is fixed vertically over the firegrate, forming one section of the boiler; and a number of these sections are placed side by side and end to end, according to the extent of boiler power that is required. The sections are elevated at the front end to such an inclination as allows all the spheres to empty themselves when the water is run off from the lowest point of each section; and this inclination is found to afford ample natural circulation of the water, the feed water being introduced at the lowest extremity in all the sections, while the steam is taken off from the highest by means of transverse feed and steam pipes connected to each of the sections. The boiler is filled with water to about two-thirds of its content, the upper spheres being employed for drying the steam. The spheres are each 8 in. outside diameter, and ⅛ in. thick, and have been tested by hydraulic pressure up to 1500 lbs. per square inch, without showing any signs of injury; and no case has occurred of an explosion of any of the spheres, nor have they given any trouble from leakage at the joints. The boiler possesses complete freedom from accumulation of scale, as the whole of the scale is washed out in small thin fragments when the boiler is blown out at the end of each week, the total quantity of water contained in the boiler being very small compared with that in ordinary boilers of the same power. The result of many months' continuous working of the boilers has been found to be that no accumulation of scale has taken place in the spheres, nor have their inner surfaces required any cleansing since they were put to work; while ordinary Lancashire boilers, working in the same situation, and with the same water, have speedily become coated with a thick scale, requiring removal with a hammer. The new boiler has been found to give a good evaporative duty; and the steam is completely dried and partly superheated by the large extent of surface exposed to the heat from the fire by the upper spheres, which form the steam-room of the boiler. These cast-iron boilers have been at work for several years in America, and for upwards of two years in London and Manchester, with complete success. A specimen was exhibited of one of the sections of the boiler, and also of the feed and steam pipe connections at top and bottom of the several sections. Samples were also shown of the small fragments of thin scale blown out from the boiler in regular working; and of the thick scale from the interior of an ordinary Lancashire boiler, using the same water.

The next paper was "On the Distribution of Weight on the Wheels of Locomotives," by Mr. JOHN ROBINSON, of Manchester. A review was given of the several arrangements that are at present adopted in this country for the wheels of locomotives, showing the different distribution that is effected of the weight in each case, and the advantages or objections attaching to the different plans. The general principles of the distribution of the weight were considered, in reference to length of wheel-base, length of connecting-rod, and proportion of weight on the driving and on the leading wheels; and attention was drawn to the distinction between the total weight of the engine upon the rails and the adjustable weight of the engine above the springs, and also to the effect which the position of the centre of gravity of this latter portion produces upon the distribution of weight on the wheels. Where connecting levers are introduced to connect the springs of different wheels, it was shown that no advantage is gained as regards the distribution of the weight, since any distribution obtained with the connecting lever can be effected equally well with independent springs by a corresponding adjustment of the spring-links. In the particular case of a six-wheeled engine, with the four hind wheels coupled, having the centre of gravity in front of the driving-axle, the insertion of a connecting lever, to equalise the weights on the driving and trailing wheels, causes a loss of driving adhesion, by throwing an increased lode on the leading wheels, as was shown by a working model exhibited at the meeting.

The meeting then terminated, and it was announced that the next would be the annual provincial meeting of the institution, to be held in Glasgow in the first week in August.

INSTITUTION OF CIVIL ENGINEERS.

At the meeting of members on Tuesday,—Mr. J. R. McCLEAN (President) in the chair—the paper read was "On the Means of Utilising the Products of the Distillation of Coal, so as to reduce the price of Coke; with descriptions of the Ovens, and of the best Processes in use in Great Britain and on the Continent in the Manufacture of Coke," by M. Pernolet, of Paris.

The author believed that this question had been practically solved by the employment of existing ovens, to which certain inexpensive additions were made, and which, while still giving to the coke all the solidity, density, and lustre that distinguished good coke made in the ordinary way, enabled every product of the distillation of coal to be turned to account. This was effected, mainly, by keeping the coal from all contact with the air during its distillation, by performing that process very slowly, and by collecting and making use of the volatile products. The whole arrangement had been sanctioned by many years' experience, both in Belgium and France, where it was actively and profitably pursued at 10 different establishments, with more than 400 ovens of the largest dimensions, capable of receiving from 5 to 7 tons of coal at each charge.

In converting an old oven into one of the improved form, the floor was taken up and raised about 1 ft., so as to allow of its being heated from below by means of a fire-grate and flues. A new opening was made in the roof, in which was fixed a pipe, intended to receive the volatile products, and to conduct them to their destination. The ordinary door and the other opening at the top were so arranged that they could be kept hermetically closed. A chimney was also added to the masonry of the old ovens, and this was an essential part of the system, as it secured the circulation of the products of distillation. It had been ascertained that this chimney should be 50 ft. high, and not less than 3½ ft. square, inside dimensions, for a group of 16 contiguous ovens; and that the sectional area of the main flue, connecting the different ovens with the chimney, should be three-fourths that of the chimney. In order to try whether the distillation was finished in any one oven, a valve was closed in the outlet-pipe; when if the charring was incomplete, the gas still given off would cause cracks in the loam, with which the joints of the door were closely luted, and thus the necessity for continuing the process was demonstrated. The valve was then simply re-opened, so as to allow the gas again to pass off by the pipe. If, on the other hand, when the valve was closed no gas escaped at the joints, the charring was known to be finished, and the coke was fit to be drawn. During this operation the valve was closed to prevent the mixture of the external air with the gases circulating in the outlet-pipe, and the cast-iron cover of the opening at the top was kept shut, to avoid the risk of igniting the coke by the draught of air which would be created if it were open. The oven was arranged for charging from the top by means of wagons running upon rails, and in this way 5 tons of coal could be introduced in 15 or 20 minutes, a rapidity which was most desirable for preserving the heat of the oven. When the charge was being withdrawn and replaced, the gas from the other ovens was allowed to pass continually in the fire-place, so that the floor was kept hot, and the gas accordingly began to show itself above the opening at the top, only a few minutes after the closing of the door. This opening was then hermetically sealed, and the valve in the outlet-pipe being raised, the communication was re-established between the interior of the oven and the great common flue. The products of the distillation were drawn off by the draught of the chimney, together with the condensation of the liquid, and the cooling of the gaseous products. After circulating in the great general flue, the products penetrated into the condensing apparatus, where they deposited most of the tar and ammoniacal liquor, and returned to the ovens by the small general flue, whence the gas, purified and dried, passed to each fire.

The time occupied in charring varied with the nature of the coal, and the density desired for the coke, and with the arrangement of the oven. At St. Etienne it took upwards of 72 hours, with rich coal, while at Torteron the time occupied was only 24 hours, with the rather poor but flaring coals of Commentry. As to the cost, it was stated that the expense of altering each oven at St. Etienne was about 20*l*., and that as the value of the additional yield from each oven ought to be about 60*l*. per annum, this outlay should be repaid by four months' work.

It was asserted that the supplementary products due to these arrangements were—a larger yield of coke, and all the tar, the ammoniacal liquors, and the gas, which would be obtained from the same coals if distilled in the retorts of a gas manufactory. Thus, in the great coke-works at St. Etienne, the yield had been advanced from 58·8 to 69·3 per cent., and in the Founderies et Forges d'Alais from 54·6 to 69·5 per cent. Generally speaking, with rich, or partially rich, coals, the increase in the yield of coke was from 10 to 15 per cent. As to the tar, the proportion collected depended on the nature of the coal, and the care taken, both in the distillation of the coal and in the condensation of its volatile products. It has averaged 2·53 per cent. at the Forges d'Alais, 3 per cent. at Etonges, 3·25 per cent at St. Etienne, and had reached as high as 5 per cent. from the ovens of the Paris Gas-Light Company, where only very bituminous coals were employed; but it was thought that there might be reckoned 3 per cent. of tar from the bulk of the coal distilled. The proportion of ammoniacal liquors depended also on the quantity of moisture contained in the coal; but it might be stated at a weight of not less than 10 lbs. of sulphate of ammonia, and sometimes it was as much as 13 lbs. per ton of coal distilled. At the ovens of the Paris Gas-Light Company from 10,000 to 11,500 cubic feet of purified gas were generally obtained from a ton of coal, which yielded from 69 to 70 per cent. of coke, fit for delivery to the railway companies.

LONDON ASSOCIATION OF FOREMEN ENGINEERS.—On Saturday evening the ordinary monthly meeting took place in their temporary quarters, Dr. Johnson's Rooms, Essex-street, Strand. Mr. Newton (of the Mint) filled the chair, and an interesting discussion, adjourned from a previous meeting, took place upon the "Double Cylinder Engine." The balance of opinion among the assembled foremen was certainly in favour of the combined high and low pressure steam-engine, although there were present some advocates of the single cylinder. Mr. Stanley and Mr. Newton were the principal speakers. Finally, it was announced that Mr. Walker, of Messrs. Maudslay's, would read a paper early in June, and at the same place, on "The Screw-Propeller." Prior to the discussion, it may be stated that four new members were elected, and several others were proposed. Altogether, this society seems to be in a highly prosperous condition, numerically and financially—a fact in which we rejoice.

IRON ARCHITECTURE.—A limited liability company, with a capital of 500,000*l*., in shares of 25*l*. each, is in course of formation, under the title of the IRON ARCHITECTURAL AND ENGINEERING COMPANY, for developing the inventions of Mr. W. VOSE PICKETT, whose proposition to substitute iron for other materials in every description was alluded to in the *Mining Journal* of July 24, 1862. It will be remembered that Mr. Pickett sets out upon the hypothesis that metal should have a distinct architecture of its own. He considers that the six primary principles of the new system are—1. Canister, or hollow, iron walls, with cast chased or repousse work ornamental surface, as a substitute for the solid wall and ashlared surface used in masonry.—2. Interstitial ornamental form, as a substitute for surface-carved, prominent, or basso-relievo form in masonry.—3. In close connection with the first, and in contrast with the second principle, is the metallic low relief or intaglio form; this, though involving no invention, constitutes with the second two distinct characters to that of the one principle of relieve form in masonry.—4. As a substitute for the columnar portico, colonnade, and arcade of the ancient system, the metallic offers the suspension portico, the advantages of which are numerous.—5. The angular forms, so prevalent in all directions in masonry, may be altogether dispensed with by the introduction of the curves of which metal so readily admits.—6. The sixth primary principle consists in the application of a coating of some kind, indispensable to iron, such as of glass enamel in colour, offering a cheap process of almost eternal durability. Mr. Pickett contemplates that a higher order of beauty, as well as a much larger amount of utility, and various other advantages, may result from the use of this material over any pre-existing architecture. As a commercial speculation, and judging from the profits of the iron-building trades, which have heretofore been in private hands, Mr. Pickett anticipates that the company will be able to divide at least 10 per cent. per annum, and that when in full working order the company will be enabled to deliver a town complete, with church, bridge, and all necessary public buildings, in ten days after receiving the order. As a proof of his confidence in the enterprise, Mr. Pickett will accept the purchase-money for his designs in paid-up shares, and undertake the office of architectural managing director, at a salary, in order that the interests of the undertaking may be promoted by his superintendence.

CORNISH PUMPING ENGINES.—The number of pumping engines reported for March is 34. They have consumed 2230 tons of coal, and lifted 17·7 million tons of water 10 fms. high. The average duty of the whole is, therefore, 53,500,000 lbs. lifted 1 ft. high, by the consumption of 112 lbs. of coal. The following engines have exceeded the average duty:—

Cargoll Mines—Michell's 72 in.	Millions 56·0
Cook's Kitchen—50 in.	59·2
Crane—70 in.	74·7
Great Wheal Busy—Harvey's 85 in.	59·0
Great Work—Leeds' 60 in.	63·9
North Roskear—Doctor's 70 in.	56·1
North Wheal Crofty—Trevenson's 80 in.	55·0
South Wheal Frances—Marriott's 75 in.	70·6
Stray Park—64 in.	54·1
Treloweth—60 in.	54·0
West Caradon—Elliot's 50 in.	62·6
West Wheal Seton—Harvey's 85 in.	62·0
Wheal Ludcott—Willcocks' 50 in.	57·2
Wheal Margery—Weisley's 45 in.	60·3
Wheal Seton—Tilly's 70 in.	64·7
Wheal Tremayne—Michell's 60 in.	57·3

NEW INVENTIONS.

PROVISIONAL PROTECTION for six months has been granted for the following—

H. GREAVES, Westminster.—Improvements in the construction of railways and tramways and in constructing and unloading wagons used thereon, parts of which improvements are applicable also to other purposes. March 8.

T. BRIGGS, Manchester.—Improvements in apparatus to be used for pumping water out of mines, and other purposes. April 4.

C. J. L. LEFFLER, London.—Improved apparatus for grinding or pulverising minerals and other substances, and mixing or amalgamating the same with oleaginous and other liquids. April 7. [and in apparatus therefor. April 9.

J. NISBET, Lanark, North Britain.—Improvements in getting or cutting minerals.

T. R. CRAMPTON, Westminster.—Improvements in the manufacture of bricks and similar articles from clay and brick-earth, and in apparatus to be used in such manufacture. April 13.

H. BENNETT, Wombridge, Salop.—Improvements in puddling iron, steel-iron, and steel, and in apparatus or machinery for facilitating the operation of puddling. April 23.

LETTERS PATENT have been issued for the following:—

G. H. JENSON, New York.—A new method of constructing lighthouse-towers, shot-towers, chimneys, blast-furnaces, cupola furnaces, conduits, monuments and columns, grain-buildings, and buildings for storing crude and refined oils. Feb. 19.

W. POPE, Bristol.—Improvements in machinery for breaking or crushing stones. Oct. 31.

S. HOLMAN, London.—Improvements in machinery for raising and forcing fluids, parts of which improvements are also applicable to steam-engines, blast-engines, exhausters, and other machines. Oct. 31. [for smelting. Nov. 4.

J. THOMAS, Surrey.—Improvements in preparing ores and earths containing copper

J. WHITWORTH, Lancaster.—Improvements in the treatment and application of steel and homogeneous metal. Nov. 5.

J. GJERS, York.—Improvements in lifts, or machinery, or apparatus for raising and lowering weights. Dec. 22. [Dec. 28.

J. GJERS, York.—Improvements in kilns for calcining ironstone and limestone.

LIST OF SPECIFICATIONS published during the week:—

Extracting minerals from mines, 4d.; manufacture of iron and steel, 4d.; manufacture of steel, 4d.; crushing machines, 4d.; furnaces, 4d. L. DE FONTAINEMOREAU.

INDURATION OF IRON.—The iron work of the new bridge at Blackfriars is to be indurated by a process patented by Messrs. Morewood and Co., and is alike important from the great cost which will be incurred, and the testing of a rather abstruse chemical formula for the preservation of iron from oxidation and decay. The process is as follows:—The iron is to be thoroughly cleaned, and heated to the requisite temperature in a furnace planned by the inventors. When this temperature is attained, it is to be plunged into a bath of prussite of potash, and chloride of potassium, in a molten state, so that when the iron is withdrawn it may easily part with the surplus of the aforesaid chemicals, which should run off like oil. The iron is then to be dipped into boiling water, containing a certain proportion of cyanide of potassium; from thence it is removed to a bath for a final washing, and set up on end to dry. All the processes are to be carried on under cover, and before exposure to the atmosphere the iron is to be coated with an asphaltum paint twice, at given intervals; and again it is to receive two coats after fixing. Of course, all the necessary planing, drilling, and fitting is to be done preparatory to the indurating. The time the iron is to remain in the bath will vary from one to five minutes, according to the weight of the metal to be operated upon. The elaborate character of the process to which the contractor is rigidly bound, will account for the large sum to be expended in carrying out this part of the work: 4*l*. per ton is allowed to the contractor for the induration and painting; Messrs. Morewood will receive from the contractors 5*s*. per ton as their royalty, which it is estimated will be 1000*l*. Thus, 16,000*l*. is to be spent in this effort to prevent oxidation, no greater proof of which, in its damaging results, can be offered than the case of the cleaning of the oxide (or rust) from the Menia Bridge, from which has lately been removed above 40 tons of oxide of iron.—*Mechanics' Magazine*

IMPROVEMENTS IN IRON-MAKING.—It is well known that iron undergoes three processes before it is fit for the forge—smelting, refining, and puddling. The smelting-furnace only yields pig-iron, which is a combination of iron with as much carbon as it can take without becoming plumbago, and the subsequent operations tend to deprive it of its superabundant carbon in order to render it malleable. A new process has now been invented, by which malleable iron may be obtained direct from the smelting-furnace; it consists in driving oxide of iron into the furnace by means of the ventilator, whereby all the carbon is at once absorbed. In order to apply this method, the hearth of the smelting-furnace must be built somewhat higher than usual, and the air driven in by the ventilator is previously made to pass through three chambers, in which it becomes charged with oxide of iron at a high temperature, the atmospheric pressure being at the same time kept very high.

The dangers arising from the universal adoption of the common lucifer-match have induced chemists to seek a substitute for it. M. Peltzer has recently proposed a compound which is obtained in the shape of a violet powder, by mixing together equal volumes of solutions of sulpate of copper, one of which is supersaturated with ammonia, and the other with hyposulphite of soda. A mixture of chlorate of potash and the above powder will catch fire by percussion or rubbing; it burns like gunpowder, leaving a black residue. M. Viederhold proposes a mixture of hyposulphite of lead or baryta, or chlorate of potash, for matches without phosphorus. The only inconvenience of this compound is that it attracts moisture too easily.—*Galignani.*

PUMPING ENGINES.

It would be folly to deny that a very strong prejudice still exists among engineers against the use of rotative engines for pumping large quantities of water from great depths; and it is not too much to say that experience has apparently shown that this prejudice is in some measure well founded. All the objections, however, which can be raised against this class of pumping machinery are founded on certain assumed conditions, which may or not be observed; and in this fact lies a weakness, so great that the objections may be upset altogether, by going the right way to work. We have already stated that nearly, if not all, the work performed by the steam in a Cornish engine, is involved in elevating a certain weight, not of water, but of wood and iron, in the shape of "bobs" and pump-spears, to a certain height; and that the water is in turn raised solely by the subsequent descent of this weight, so that the duties performed by the steam are one thing, and those performed by gravity quite another. Formerly, very few Cornish engines did more in the way of raising water on the indoor stroke than just enough to fill the pump barrels, from which the water was subsequently forced up by the descent of the plungers. Now, deep lift-pumps are frequently employed, and then the steam raises water to a certain extent; but even in these cases the height to which it is raised on the indoor stroke is very moderate indeed, as compared with the whole distance from the surface of the water in the sump, or pump-well, to the level of the discharging pipes, so that, even when applied to these engines, the arguments we have already brought foward will be in the main found to hold good. Now, in the division of labour, the secret of the superiority of the Cornish over the rotative engine really lies; because this division of labour is an expedient, by the aid of which the contending interests of the water and the steam are, if not reconciled, at least rendered compatible with each other. But it does not therefore follow that these interests cannot be reconciled by other and simpler means just as well, and if they can, the theoretical superiority of the Cornish engine as an hydraulic machine disappears. Steam being comparatively devoid of weight, is pratically devoid of momentum when put in motion. We can turn it as suddenly as we please into a cylinder; we can arrest its flow through the longest mains when proceeding at the highest speed, without fear of the consequences; and, for the same reason, no appreciable loss of power will follow from the sudden arrest of its progress. There is no momentum to be expended on something—the fracture of a main, or the splitting of a cylinder. In this peculiarity lies one of the great advantages which the steam-engine possesses over machines worked by the effect of gravity. This it is that enables us to cut off steam at any portion of a stroke we please; even when the piston is moving at a maximum velocity; or to reverse its motion through branch pipes, or combination cylinder ports, without waste of power. But the case is far different with non-elastic heavy fluids, such as water. The little momentum steam has expended, when expended at all, in its own condensation, in compressing its particles into a closer proximity. The sudden arrest of a long column of water in rapid motion, on the contrary, may be productive of the most disastrous results, unless special means are provided to absorb its momentum, either to the end that the power represented may be stored up for future use, as in an air vessel; used at the moment, as in the water ram; or wasted, as when a relief valve is forced open and a certain quantity of the liquid be suffered to escape.

Now, the whole operation of working a steam-engine depends for success on the fact that steam may be stopped in its flow at pleasure, and that each separate cylinder full is capable of doing its work when perfectly isolated from all other steam. Turn a head of water into a steam cylinder, fitted with ordinary steam valves, and albeit the initial pressure on the piston is even less than that of the steam which commonly puts it in motion, the whole machine will, ten to one, go to pieces in one minute. Nevertheless, manageable as steam is, it has its own peculiar laws, which must be attended to; and one of these is, that it ill brooks delay in performing its task. Suffer a certain quantity of steam to enter a cylinder behind a piston, and the more quickly it can force that piston to the end of its stroke, the less will be the loss by condensation, and the better will be the work performed. In the Cornish engine we find that the time occupied in raising the spears is a matter of no consequence whatever, only provided it does not exceed a certain space. The weight, then, is there at one end of a beam, the steam is turned into the cylinder at the other end, and, being there, its work is cut out of it, and may be performed, so to speak, just at that rate which it finds most convenient without limitation of any kind. Thus, we know of instances where a weight of 80 tons is lifted nearly 11 ft. in one second.

When we have to deal with water, however, we find that the case stands very differently. If water is not allowed to move at a definite velocity it will do no work at all. Thus, if the rim of a water-wheel move at the theoretical velocity due to the height of the fall, no strain will be exerted on it by the water, and therefore all the work done will be involved in the impartation of motion to the particles of the water, and none will be left available for other purposes. Careful experiments have decided long since that the best velocity for the periphery of an overshot wheel should not exceed 6 ft. per second, nor be much less than 3 ft. in the same time. When we come to force water through pipes, or to raise it by pumps, we find that there are certain laws which must be observed, as to the rapidity of motion enforced, &c., from which no departure can be made without wasting power. The Cornish engine specially provides for this. The steam raises the weight how it pleases, and observes its own laws. But the weight is carefully regulated in the rapidity of its descent, so that just that motion shall be imparted to the fluid raised which experience dictates as the best possible for the attainment of the end in view. We thus see that the laws regulating the motion of both fluids are carefully observed, the balance-bob forming the link between each, and acting as a mediator or ambassador to reconcile existing differences.

In the rotative engine the steam is employed directly in the elevation of the water; and instead of having to do with a weight which may be raised "anyhow," so long as it is raised, it has to deal with one whose upward speed must be carefully regulated, all whose movements must be carefully watched and humoured, and whose progress must on on account be checked or arrested suddenly. In this lies the inferiority of the rotative engine as an hydraulic machine, and there is no doubt that great care and skill on the part of the engineer are called for in the erection of any system of pumps to be put in motion by a crank-engine. Fortunately, steam permits of a great deal of variety in the velocity with which it performs its task, and thus, although water is sufficiently unmanageable, or rather unaccommodating, a steam-engine can generally be built which, although rotative, will raise water just at the proper velocity; but great care must be observed in the construction of the pumping apparatus, or the best steam-engine ever designed will fail to give satisfactory results.

The column of water in the rising mains should ascend continuously, and with the least possible variation in its speed. Now, it is impossible to attain this object, unless a large air-vessel be provided. In the case of high-speed engines, driving double-acting pumps, or more pumps than one, the air-vessel is too often looked on as a thing almost unnecessary, and although seldom or never omitted altogether, it is usually far too small; as a result, the velocity of the ascending water is intermittent, instead of very nearly constant, and a great deal of power is wasted at each stroke in the impartation of a momentum, which is subsequently useleasly expended. With a large and efficient air-vessel, the speed of pumps can always be kept down, and the water raised leisurely in a stream of considerable diameter, whose motion will be continuous, notwithstanding that the number of strokes per minute made by the pumps may be very moderate. One objection made against the use of large air-vessels is, that from the large area the water surface within them offers to the compressed air absorption is excessive, and that leakage through rivet-holes, &c., is also very great. This is true, but there are one or two ways of overcoming these objections; such as placing an india-rubber bag containing air within the vessel, so that the air may be isolated from the water, In any case, it only requires a little increase in the size of the pumps, always employed when the works are large, to maintain the supply of air within in any quantity required. In one sense, the air-vessel acts the part of the balance-bobs of the Cornish engine, and the work of the steam might, without any wide departure from the truth, be regarded as through it were all exerted in compressing a certain quantity of air, which afterwards elevates the water; and steam can be much better employed in doing this than in forcing water up a main at a velocity constantly varying, and never that best adapted to the exercise of the powers of the engine regarded as a steam, and not as an hydraulic machine.

The pump valves have, perhaps, given more trouble with crank-engines than anything else. In the Cornish engine the cataract arrests for a time the descent of the spears and plungers, giving time for the valves to fall into their places; but no such expedient can be employed with the crank-engine, and all too often we find that the valves do not close until not only is the velocity of the ascending column of water checked, or wholly stopped, but the column of water actually begins to return, or descend. In fact, it may be said that with a good air-vessel this descent can only occur in the column of water between that vessel and the valve, but even this represents a waste of power, trifling perhaps, but still to be avoided. An excellent valve has been employed in some cases, which is so heavy, and offers just such an area to the ascending water, that it remains suspended, as it were, on the stream passing up through its seat, just as long as that stream maintains a given velocity. As this velocity becomes diminished as the crank approaches the dead point, the valve falls through the still ascending stream, so that it is actually down in its place before the water attempts to return on the loss of its momentum, and there is no loss whatever by the regurgitation of the water, which usually takes place while the ordinary valves are in the act of closing. With a slow speed of pump, a heavy fly-wheel, good valves, an efficient air-vessel, and steam cylinder carefully clothed and worked with superheated steam, or else jacketted, there is no good reason why the crank-engine should not easily compete with the Cornish engine in economy of fuel, while as to first cost the balance is all in favour of the former. We feel little doubt that no difficulty would be experienced in providing a very excellent rotative engine and pumps, with house, stack &c., complete, for about 50*l*. per horse-power, while a by no means uncommon price for the Cornish engine is 100*l*. per horse. It is true that this includes a palatial engine-house, but even if we consider this as unnecessary, and take off 25*l*, per horse in consequence, and rest content with a plainer building, we find that the invested capital, which is worth, including depreciation, 10 per cent. per annum at least, represents interest enough to run away with most of the boasted advantages of the Cornish over the rotative engine. It must be remembered, too, that the Cornish engine has existed since the days of Watt, and has received a vast amount of attention from men who strained every nerve for long years to figure well in the published duty reports, whereas the rotative pumping-engine of large size is, in some measure, of recent growth, and never yet has received the attention of which it is really worthy.—*Mechanics' Magazine.*

BLASTING ROCKS.—A very simple and effective invention for blasting rocks has been patented by Mr. D. S. Sutherland, of 34, Great George-street, Westminster. He proposes to introduce into the bore-hole a cone, either of wood or hollow metal, between the powder and the outer side of the hole. The apex of the cone is outward, and the hole is then filled up with sand, sufficient room only being left for the passage of the fuse. The effect of this cone is that the force of the explosion is much increased, the sand rendering the blowing out of the cone impossible.

NEW BORING MACHINE.—A very useful and simple rock-boring machine is stated to have been lately employed at Spezzia, in cutting one of the tunnels between that port and Genoa. It is asserted that it cuts at such a rapid rate that, if employed in the Mont Cenis excavation, the work would be completed in three years instead of eleven, which is at present supposed to be the period which must elapse before it is finished. Another alleged feature in connection with the machine is that of extraordinary economy of labour, three men and a boy being sufficient to work it, whilst it can be driven either by steam or compressed air.

A NEW ALLOY, described as applicable to the manufacture of all metal articles, bells, hammers, anvils, rails, and non-cutting tools, has been patented by Mr. M. H. Micolon, of Paris. The alloy consists of iron with manganese or borax. The patentee takes 20 parts of iron turnings or tin waste, 80 parts of steel, 4 parts of manganese, and 4 parts of borax; but these proportions may be varied. When it is desired to increase the tenacity of the alloy, 2 or 3 parts of wolfram are added. When the cupola is ready, the iron and steel are poured in, and then the manganese and borax; finally, the vessel is filled up with coke; the metal is thus in direct contact with the fuel in the cupola, and by quickly running the fused mass into moulds, bells which possess the sonority of silver, whilst the cost is less than bronze, may be obtained.

FOREIGN MINES.

EAST KONGSBERG.—April 21: South Ramsrud: The vein in this mine, which has been rather poor during the past fortnight, is again showing native silver, the sure precursor of silver in this mine. Arsenical iron is in considerable quantities disseminated through the vein.—Middle Ramsrud: There is no change to notice in the character of this mine—still poor.—North Ramsrud: The vein in this mine is about 3 inches in width, and showing traces of native silver.

April 29.—South Ramsrud: The vein in this mine has this week yielded good schelderts (or dressing ore) from the bottom of the Gesenk (specimens from this vein shall be forwarded next week—these will show the character of the vein).—Middle Ramsrud: The vein in this mine averages 2 inches in width; it continues poor.—North Ramsrud: This mine has given a little native silver this week from the bottom of the Gesenk; the vein averages 3 inches in width.

PONTGIBAUD.—W. H. Rickard: Roure: The 80, south of Richards's shaft, is unproductive. The same level, driving north of junction, south of shaft, yields 2 tons of ore per fathom. The 80, north of shaft, is poor. The 60 south yields 1 ton of ore per fathom. The same level, south of cross-cut, on Emily's lode, is unproductive. The 40 south of Agnes' shaft, yields ¾ ton of ore per fm. The 20, in the same direction, yields stones of ore, and looks kindly for a speedy improvement. The adit south of Virginie's shaft is in a large kindly lode, composed almost entirely of quartz, without any lead ore. The stollen south of James's shaft, on the eastern part of the lode, has met with another lode, composed of quartz, running at nearly right angles to the direction of the part we were driving on; it is a large kindly looking lode. We have working in this mine the following stopes:—One in back of the 80, north of Richards's shaft; four in back of the 60, at the same shaft; three in back of the 40; three in back of the 40, south of Agnes' shaft; two in back of the 20; one in back of the adit; and one in back of the stollen; and thirty tribute pitches, which together yield a fair quantity of stuff for the laveries.—La Grange: The lode in the 40, at Nesky's shaft, is cut into 3 metres, which yield 2 tons of ore per fathom; we are not yet quite through it. The 20, north of the same shaft, yields a little saving work, and promises improvement. The winze below this level, north of shaft, yields 1¾ ton of ore per fathom. The adit north is improved in appearance, and yielding a little saving work. The adit west from La Rancoule advances rapidly; we drove 20 metres last month, and if the ground continues shall drive quite as much this month.—Mioche: The 100 north, on No. 3 lode, yields stones of ore, but not to value. The 100 cross-cut west is still in lodey ground, composed of quartz and decomposed gneiss, with a little barytes. The 80 north opens a little tribute ground. The adit cross-cut west from Railway level is not quite so hard for driving. The lode in the shaft on the north hill is become very small; we have set to drive on its course. Our tribute pitches in this mine are rather poor.—La Brousse: The part of the lode carried in the shaft sinking from surface has yielded about 1¼ ton of ore per fathom, and continues about the same value; we have set the shaft to six miners with labourers, there being an increase of water.—Pranal: The winze in the bottom of the 70, on Amantine's lode, will be holed to the rise in the back of the 90 in a few days. Susan's Lode: The 70 north yields stones of ore and blende, but not enough to save. The 50 north is unproductive. The 30 south is holed to the old workings on Henri lode. The 30 north yields ⅛ ton of ore per fathom. The 8 north is being driven on a slide, to cut the western part of the lode. The same level, on the eastern part of the lode, yields ¼ ton of ore per fathom. The 8, south of No. 2 cross-cut, on No. 2 lode, is poor. A winze sinking below this level, on the main part of the lode, opens tribute ground. We have three stopes in this mine and twelve tribute pitches, yielding together about our usual quantity of ore.—Surface: Our dressing has been going on without interruption up to the last week; since then we have had a lack of water for the water-wheels, obliging us to stop the fine crushing. Our samplings amounted to 260 tons.

SANTA BARBARA.—Capt. Bryant, Pari, March 28: I have to advise that Mr. Thomas Dunstan left here on the 25th, in charge of 3194 ozs. of amalgamated gold, equal to 368·214 ozs. troy; he will also take charge of the Don Pedro and East Del Rey Companies' gold at Morro de St. Anna, as per agreement with these companies. He takes animals from this for the conveyance of the two miners up the country, and will also take charge of bringing them up. The whole quantity of stone stamped during the quarter was 1170 tons, average produce 2·730 ozs. per ton=3194 ozs.—shallow level, 334 tons, produce 1·5, 498 ozs.; trial level, 54 tons, produce 1·0, 54 ozs.; shaft, stopes, and adit, 784 tons, produce 3 337, 2642 ozs. During the quarter there has been rejected from the shallow level 56 tons, ditto from shaft and bottoms 94 tons, together 150 tons; about 90 tons of this has been stamped, with 415 tons sand. The gold from the sand is included in the above amount, and the remainder of the rejected stone is still on the floors, and will be operated on as opportunity offers. The produce of stone from the shallow level has been arrived at by stamping 81 tons over the ripples at three different periods during the quarter, and an avarage, taken the whole produce of the sand, is calculated in the shaft, bottoms, and adit; the sand from the shallow level was not considered worth re-treating, and consequently allowed to pass off.—Mine: In Carne's shaft there is no alteration worthy of notice, the lode continuing about the same size: in consequence of the continued rains the roads have been in such a state that we have found it impossible to carry stone from here to the stamps in quantities, so as to make a fair trial of its worth: the same will apply to the stuff from the trial level, from which we have made two or three attempts, but the river has been so high it has been impossible to pass with the cars. Our progress with this has been rather slow; the leader part of the lode continues from 6 to 8 in. wide, and no rock as yet. The adit level as last reported. In the shaft there has not been much done, having an increase of stuff from the stopes it has prevented our sinking much during the past fortnight, but having made arrangements for remedying this, we hope to go on sinking regularly in future. The lode in the stopes is quite equal to what we have at any time seen it. In the bottom of the shallow level we have restricted our operations to sinking a part about 3 fms. long, expecting as we go deeper the lode will improve, as it has done in the shaft and bottoms. Though the amount of gold has fallen off when compared with the previous quarter, yet it is gratifying to find that the produce from the deepest part of the mine is increasing, it being for the past quarter 3·337 ozs. per ton. I hope during the ensuing quarter that we shall be able to quarry a greater portion of stone from that part, and thereby increase the quantity of gold raised.

NOVA SCOTIA LAND AND GOLD.—The company have received advices from their managing director in the colony up to the 28th ult., and a remittance in bar gold from the produce of their mines at Sherbrooke to the value of $3500. They have also received a remittance of $5000 on account of $15,000 for a re-sale of an outlying property at Wine Harbour. The advices state that the prospects for the future were never better. The following are extracts from the *Halifax Morning Chronicle* of the 28th ult.:—Yesterday Mr. Stewart Campbell laid on the table of the House of Assembly a box, containing a large number of splendid specimens of gold-bearing quartz, procured from some of the areas owned by the Nova Scotia Land and Gold Crushing and Amalgamating Company at Sherbrooke, in the county of Guysboro'. The various pieces were rich in gold, and excited the admiration of the members present, all of whom examined them minutely, and evidently with a considerable degree of interest. The various mining localities in the province are just now attracting a large amount of attention both at home and abroad. We understand that Mr. Armand, managing director of the Nova Scotia Land and Gold Crushing and Amalgamating Company, brought up from Sherbrooke on Tuesday 155 ozs. of gold, besides some very fine specimens, the result of four weeks' mining in that locality, principally from the celebrated "Bluehead."

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